Reunification and Hyperseeing

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In a seashell we see the oneness of art, mathematics, and architecture. A seashell is an abode that is also an ingenius spiral form-space sculpture. Seashells also display a variety of beautiful two-dimensional designs on curved surfaces. Thus the oneness of art, mathematics, and architecture was already genetically coded in these very early life forms. I can imagine what it was like to have experienced the excitement of living in Florence during the Renaissance when there was no separation between art, mathematics, and architecture. This unification also resulted in a mutual enrichment of these fields. It is my purpose to energize a move toward a reunification of these fields in education.

For the record, I have been a professor of mathematics at the State University of New York at Albany (SUNYA) since 1968. In 1971 I took a sculpture course at SUNYA and have been avidly carving wood and stone ever since. In 1980 I introduced an interdisciplinary course Art, Mathematics, and The Creative Process. Art and mathematics are both involved with seeing relationships. One can also see certain mathematical forms as art forms and creativity is about seeing from a new viewpoint. Thus its all about seeing. As the Spanish sculptor Eduardo Chillida states "to look is one thing, to see is another thing", "to see is very difficult, normally", "to look is to try to see", "I have looked and I hope I have seen" [C]. An excellent related article is [L]. In education we have the 3R's and now its time to add the S (for seeing).

In 1992 I organized the first art and mathematics conference (AM92) at SUNYA. This has been followed by AM93, 4, 5, 6 and 7. The AM conferences have been a wonderful experience. As Steve Whealton said at AM97, "I found my tribe". For me, the gift from the AM tribe has been learning to see in exciting new ways.

In particular, the sculpture *Attitudes* by Arthur Silverman led me to a deeper understanding of the concept I refer to as hyperseeing. First, note that in order to see a two-dimensional painting on a wall, we step back in the third dimension. We then see the shape of the painting (generally rectangular) as well as every point in the painting. Thus we see the painting completely from one viewpoint. Now to theoretically see a three-dimensional object completely from one viewpoint, we would need to step back in a fourth dimension. From one viewpoint, we could then (theoretically) see every point on the object, as well as see every point within the object. This type of all around seeing as well as a type of x-ray seeing was known to the cubists such as Picasso and Duchamp and is discussed in [H]. In particular, cubists were led to showing multiple views of an object in the same painting.

In mathematics four-dimensional space is referred to as *hyperspace* and I refer to (theoretical) seeing in hyperspace as *hyperseeing*. Thus in hyperspace one could hypersee a three-dimensional object completely from one viewpoint.

Although we do not live in hyperspace, it is still desirable to attain a type of hyperseeing. This is possible when viewing Attitudes by Arthur Silverman, shown on the cover. Silverman placed six copies of the same object on separate bases in six different orientations. The object consists of a rectangle, parallelogram, and two triangles. People viewing the six separate sculptures often do not even realize that it is the same object. I refer to the set of six sculptures in Attitudes as a hypersculpture.

In general, a *sculpture* is defined as an object in a given orientation relative to a fixed horizontal plane (the base). Two sculptures are said to be *related* if they consist of the same object in different orientations. Note that it may not be obvious that two sculptures are related. A *hypersculpture* is a set of related sculptures. As in the hypersculpture Attitudes, there are abstract three-dimensional objects that have several interesting orientations. To more completely appreciate the diverse sculptural content of the object, it is natural to present it as a hypersculpture. Furthermore, the experience of viewing a hypersculpture allows one to see multiple views from one viewpoint which therefore helps to develop a type of hyperseeing in our three-dimensional world. A more complete discussion is given in [F]. Also see [B], [R1], and [R2].

One can also consider "hyperseeing" a single sculpture in our three-dimensional world as described by the world-renowned sculptor Henry Moore:

"This is what the sculptor must do. He must strive continually to think of, and use, form in its full spatial completeness. He gets the solid shape, as it were, inside his head – he thinks of it, whatever its size, as if he were holding it completely enclosed in the hollow of his hand. He mentally visualizes a complex form from all round itself; he knows while he looks at one side what the other side is like; he identifies himself with its center of gravity, its mass, its weight, he realizes its volume, as the space that the shape displaces in the air."

Moore also carved spaces through the form:

"The liking for holes came about from wanting to make space and three-dimensional form. For me the hole is not just a round hole. It is the penetration through from the front of the block to the back. The space connects one side to the other, making it immediately more three-dimensional. A space can itself have as much shape-meaning as a solid mass. Sculpture in space is possible, where the stone contains only the space, which is the intended and considered form."

From the above quotes we gain a feeling for how Moore saw a sculpture as a composition of shape in both form and space. He saw from all around the sculpture as well as into and through the sculpture. This was Moore's hyperseeing and serves as a definition of hyperseeing in our three-dimensional world.

The mathematical theory of knots is an important branch of topology. Knots also suggests shapes for wonderful form-space sculptures called space curves. They are totally three-dimensional with no preferred top, bottom, front, or back and can look quite different when viewed from different directions. They are also open forms that one can see through so they are ideal examples of sculptures on which to practice hyperseeing. Two sculpture based on forms of the trefoil knot are shown in Figure 1. They are made of folded tinfoil and used for classroom exercises.

Figure 1

The examples in the following papers illustrate the richness of art inspired by mathematics. The collaboration of Brent Collins and Carlo Sequin is one of the really exciting developments in the AM world. Beth Whiteley combines geometry with a very highly developed sense of color. Arthur Silverman's passionate interest in the tetrahedron consistently yields sculptures of formal elegance. Charles Perry's sculpture inspired by mathematics and architecture is unsurpassed.

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References

[B] Thomas Banchoff, *Beyond the Third Dimension: Geometry, Computer Graphics, and Higher Dimensions*, Scientific American Library, New York, 1990.

[C] Eduardo Chillida, *Basque Sculptor*, Video, Home Vision, 1985.

[F] Nat Friedman, *Hyperspace, Hyperseeing, and Hypersculpture*, preprint.

[H] Linda Dalrymple Henderson, The Fourth Dimension and Non-Euclidean Geometry in Modern Art, Princeton University Press, 1983.

[J] Phillip Mames, *Henry Moore on Sculpture*, Macdonald, 1966.

[L] Howard Levine, *See-Duction: How Scientists are Creating a Third Way of Knowing*, Humanistic Mathematics Network Journal **15**, 1997.

[R1] Tony Robbin, *Fourfield: Computers, Art, and The Fourth Dimension*, Bulfinch Press, Boston, 1990.

[R2] Rudy Rucker, *Geometry, Relativity, and The Fourth Dimension*, Dover, New York, 1977.

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